Enhancing Social Experiences and Interactions through Gamification: The BARMBAND Wearable Bracelet

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ABSTRACT

Initiating conversations in crowded or unfamiliar social settings can be a daunting task, leading to heightened social anxiety for many individuals. *Barmband* aims to alleviate these challenges by providing an unobtrusive and intuitive means of signaling one's openness to interaction. Through its discreet light-up feature, the Barmband communicates an individual's willingness to engage in conversation. Through the use of gamification, *Barmband* aims to provide a motivational factor aiming to create a more inclusive and entertaining social atmosphere.

CCS CONCEPTS

• **Human-centered computing** → **Mobile devices**; **Interface design prototyping**; • **Hardware**;

KEYWORDS

Hardware, Wearables, LED, HCI, Social Interaction, Prototype, Social Catalyst

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1 INTRODUCTION

In the bustling ambiance of bars and pubs, where conversations are the lifeblood of social interaction, the act of initiating dialogue can often be an intimidating endeavor. Social anxiety looms large, making it challenging for individuals to break the ice and engage with strangers. Recognizing these barriers to meaningful connections in such social settings, we present *Barmband*.

Barmband is a wearable bracelet consisting of an LED strip, a microcontroller, and an RFID reader. The main goal of *Barmband* is to gamify social interactions via challenges. These challenges are supposed to act as ice breakers for engaging in conversation with strangers. Since both interaction partners have to wear a *Barmband*, willingness to communicate is guaranteed.

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2 GAMIFICATION

As our main driver for gamification, challenges are a crucial part of *Barmband*. They represent a holistic interaction process, starting with two strangers and ending in a hopefully good conversation. To further illustrate how challenges work, a detailed list of steps is given below.

2.1 Prerequisites

In order for a challenge to start, there need to be multiples of two *Barmbands* active at any given time.

2.2 Initiation

Upon manual physical interaction, *Barmband* will light up and enters a waiting state. The waiting state is being visualized by a pulsing pattern. This pattern is a signal that the device is searching for a compatible partner. When a suitable partner has been discovered by *Barmband*, it will light up in a random color and pair up with another activated *Barmband* that emits the same color.

2.3 Search

When the *Barmband* is in search mode, visually indicated by the LED strip lighting up in a solid color, wearers must look for their matching *Barmband* color.

2.4 Discovery

Once both interaction partners have spotted each other, they have to scan each other's *Barmband*.

2.5 Repetition

All subsequent initiations need to be started manually by the wearer in order not to break off an ongoing conversation. These steps can be repeated as many times as desired.

3 USE CASES

Barmband can be used at various social events where numerous strangers tend to meet. Some examples are:

Bars and Pubs. The original use case for this project. As a fun activity for patrons to spend their time, *Barmband* and its gamification aspect was envisioned.

Networking Events. Social interaction at the core, having an incentive to meet new people, makes *Barmband* especially attractive for this use case.

First weeks. With social events being popular during first weeks, new students can enjoy a novel way of getting to know new people through *Barmband*.

Big Celebrations. Weddings and big events in mind, *Barmband* can be used as a fun ice breaker to get to meet other guests.

The target audience are strangers at social events who are willing to socialize with other strangers.

As mentioned before, the need to explicitly opt into challenges after any discovery makes it easy to stick to a partner, thus promoting meaningful conversation. As mentioned by Chen and Abouzied [1], initiating a new challenge also makes it possible to get out of an unpleasant conversation.

4 RELATED WORK

In 2016, Chen and Abouzied [1] presented the *CommonTie*, an armband that implements a matchmaking system to spark interactions using visual clues. The device was tested at CSCW '14. While the matchmaking in this context was based on a shared interest in scientific papers and topics and excluded pairings that already knew each other based on social media contact information, both the authors and users responses suggest that purely random pairing may also be suitable to start enjoyable conversations.

In the corpus described by Olsson et al. [2], Barmband fits the Social Design Objective of Icebreaking. Acting as a tool to "relieve tension, alleviate social awkwardness and support people in social skills" ([2], P. 52), Barmband aims to connect where new people gather together. It does so by using the Design Approach of Matchmaking. Barmband focuses on inviting people to interact and spark the conversation, rather than suggesting topics or the gamification of the actual interaction between two people.

5 IMPLEMENTATION

5.1 Hardware

5.1.1 ESP32. The ESP32 microcontroller was chosen as the MCU primarily because of its relatively small size and built-in Wi-Fi capabilities, which are essential for enabling MQTT messaging. In addition, the ESP32 is powerful, with a dual-core processor capable of handling complex tasks. The ESP32 also offers good value for money, making it a good choice for the limited budget of €25 we had for each *Barmband*.

5.1.2 RDM6300. To scan other *Barmbands*, the RDM6300 is connected to the ESP32. It is an RFID reader module compatible with EM4100 RFID tags. The RDM6300 was chosen for its low-cost and small form factor. Unlike other RFID readers such as the RC522, the antenna is independent of the module itself, making it a good choice for a wristband.

5.1.3 RFID Tag. We use simple EM4100 RFID cards attached to each *Barmband*. This allows the *Barmband* to be scanned by other *Barmbands*.

5.1.4 WS2812 LED Strip. The LED strip is the main way of interacting with the *Barmband*, showing different colors and effects depending on its state. We chose the WS2812 LED strip because it supports RGB colors and is easily controlled by the ESP32 microcontroller. It is also flexible and can be placed around the wrist.

5.1.5 Button. A push-button switch is connected to the ESP32, allowing wearers to initiate new challenges and cancel challenges in progress.

5.1.6 Power bank. The main power source for *Barmbands* is power banks. We write about alternative power sources in 6.3.

To create a comfortable bracelet, the ESP32 and RFM6300 were stacked and soldered onto a strip board. The RFID tag was attached to the ESP32. The resulting device can be secured to a wristband using Velcro fasteners. The RDM6300 antenna is placed over the wrist along with the LED strip. This forms a comfortable bracelet that can be worn firmly on the wrist.

5.2 Operating Multiple Barmbands

Updating each *Barmband* by connecting it to a computer can be a tedious process. To address this issue, we have implemented over-the-air updates. This allows Barmbands to be updated via a web server without the need for a physical connection to a computer. During the update process, the *Barmband* needs to be on the same network.

To avoid compile time configuration of every single *Barmband*, a mechanism has been implemented to read the RFID tag ID associated with each *Barmband* used for identification within the communication. During the initial use, the *Barmband* enters a setup mode where an RFID tag must be scanned using the RFID reader. Once a tag has been successfully scanned, the *Barmband* enters normal mode and uses the ID of the scanned RFID tag as its own ID. The ID is stored in the on-board non-volatile memory (NVS) of the ESP32. This data is retained across restarts [4].

5.3 Software

The *Barmband* software on the ESP32 is based on the Arduino framework, which provides us with access to a broad ecosystem of libraries and documentation. We use PlatformIO[1] to manage our dependencies as well as building and flashing the software. The declarative management of dependencies like libraries and the Arduino framework makes it easy to create an environment that can be shared between developers and machines.

5.4 Managing application state

Like mentioned in Section 2, the *Barmband* experience goes through multiple stages. The game loop can be aborted and continued at any point at the users' will. To reflect this, the *Barmband* has to be able to move between different states as well. Incoming messages and user interactions are handled depending on the current state and cause transition into the next state.

Fig. 2 gives an overview of the different states and possible transitions.

5.5 MQTT

MQTT is a lightweight and efficient protocol that can be used to send messages between devices. The protocol is widely used by

[1] https://platformio.org/

IOT devices. MQTT is very suitable for IOT devices because these devices often need to send messages on networks with very limited bandwidth. MQTT is well suited for this due to its efficiency in message exchange. In addition, with MQTTs quality of service (QoS) levels, it is possible to ensure that messages are delivered correctly. Compared to other protocols, like WebSockets, messages sent with MQTT may be retained. This means that a message can be sent to a device that is not connected at the time of sending. When the device connects, it will receive the message. Therefore, MQTT may also be used in locations where the network connection is not stable, making it a good choice for *Barmband* [3]. We use QoS Level 2 for our communication, which guarantees that messages are delivered exactly once.

To manage multiple bracelets, *Barmband* needs some kind of management software, including a matchmaking algorithm. When using MQTT, a management software can simply be another MQTT client listening to all topics as *Barmband* sends messages in. A MQTT topic is a string that is used to identify a message. With different topics being used, not all messages are always sent to every *Barmband*. For example, a registered *Barmband* does not need to receive setup messages from other *Barmbands*. A detailed list of topics and messages is given below.

5.5.1 barmband/setup. The setup topic is used to register new *Barmbands*. When a *Barmband* is being activated, it publishes a `Hello` message to this topic along with its unique identifier, determined by the built-in RFID tag. The identifier is always being used in all messages by the *Barmband* to identify itself.

For example, a registration message might be *Hello 1FA63B9E*.

5.5.2 barmband/challenge. The challenge topic is used by *Barmbands* to request new partners and to cancel challenges. The management software uses this topic to instruct certain *Barmbands* to change their state from search mode to challenge mode, indicating that a challenge pair has been discovered by the matchmaking algorithm.

If a *Barmband* has been previously registered and wishes to receive a new challenge, it will send a `Request partner` message. As with all messages, this message contains the unique identifier of the RFID tag.

In response to a `Request partner` message, the management software will send a `New pair` message. This message contains two participants of a challenge pair, found by the matchmaking algorithm.

When a challenge is active, the *Barmband* may abort the challenge at any time by sending an `Abort` message.

Another message is sent by *Barmband* when a partner has been found. In addition to its own unique identifier, the message contains the ID of the partner found. In summary, the following messages are sent to the `barmband/challenge` topic.

- `Request partner <id>`
- `New pair <id_1> <id_2> <color>`
- `Abort <id>`
- `Found <id> <found_id>`

5.5.3 barmband/logging. The *Barmband* logs some information about the current state or errors to the logging topic.

Fig. 1 illustrates the communication between multiple *Barmbands* and the *Bandcommand* management software.

An advantage of MQTT messages and topics is that these messages can be read not only by the management software and *Barmbands*, but also by any MQTT client. This means that messages can be easily debugged. In addition, with *Barmband* we provide a basic a graphical user interface that displays all active *Barmbands*, designed to help event hosts to effectively manage the social dynamics of their event.

In order for MQTT to work, there has to be a running MQTT broker. We tested our *Barmbands* with the Eclipse Mosquitto[2] broker. While almost every broker could be used, we provide a small setup to run an Eclipse Mosquitto broker locally.

5.6 Management Software

Barmband comes with a management software, named *Bandcommand*, written in Go. *Bandcommand* subscribes to the barmband setup and challenges MQTT topic and represents another MQTT client.

Bandcommand parses messages sent by *Barmband* wristbands and therefore knows the state of each *Barmband*. An important part of the management software is the matchmaking algorithm. *Bandcommand* knows which *Barmband* has requested a partner. When a suitable partner has been found, it publishes a `New pair` message. The corresponding *Barmbands* will now enter challenge mode. *Bandcommand* ensures that only registered *Barmbands* can request a partner.

To verify the *Bandcommand* implementation without the need to handle real *Barmbands* or manually send messages via MQTT, we use a number of unit tests to test message parsing and handling.

6 LIMITATIONS

6.1 Form Factor

The current form factor of the *Barmband* presents challenges and limitations for the overall user experience. The RDM6300 RFID reader + antenna and ESP32 microcontroller affect the size and weight of the *Barmband*. Combining these components with a power bank significantly increases the size and weight of the *Barmband*, making it relatively big and potentially uncomfortable to wear for an extended period of time.

Another challenge is the placement of the RFID tag, which should ideally be easy to scan without causing inconvenience to the wearer. However, due to the current form factor, locating an effective scanning position while maintaining a compact design is challenging.

6.2 RFID

RFID technology is essential in *Barmband* as it enables users to complete challenges by scanning RFID tags embedded in each other's wristbands. However, the current design's implementation of RFID has led to several issues, including the size of the antenna. The RDM6300 RFID reader's antenna used in *Barmband* is relatively large, which limits the device's compactness. This limitation affects not only the form factor but also restricts flexibility, which may cause discomfort to the user.

[2] https://mosquitto.org/

Furthermore, the placement of the RFID tag on the opposite side of the wrist from the antenna introduces a design limitation. This placement is necessary due to a limitation of RFID technology, which can result in the reader scanning its tag when the RFID reader and the tag are in proximity.

RFID technology is generally limited by range and orientation, making it challenging to establish successful contact between the RFID reader and tag.

6.3 Power Supply

There are some significant limitations when it comes to power. Currently, a power bank is used to power the wristbands, which can have some limitations on the user experience and overall functionality of the device.

1. Battery life: Power banks have a limited amount of power they can provide, depending on their capacity. Prolonged use of *Barmband*, particularly with the LED lights flashing continuously, can quickly drain the battery. For an event that lasts several hours or even a whole day, this could mean that the *Barmband* may not last the entire event.

2. Portability: While there are compact and lightweight power banks, having to carry a separate device just to power the *Barmband* can be inconvenient.

3. Charging: The need to constantly recharge the power bank between uses is also a limitation. Users could potentially forget to do this, making *Barmband* unusable when needed. It also means that the *Barmband* cannot be used continuously and requires downtime to recharge the power bank.

These limitations present potential challenges to the user experience and reliability of the *Barmband* that will need to be addressed in future iterations and improvements of *Barmband*.

6.4 Visibility of LED

One of the potential limitations of *Barmband* is the visibility of LED lights. The LED strip serves as the primary mode of interaction, indicating status and pairing progress through various colors and patterns. However, the effectiveness of these LEDs can be negatively affected in certain circumstances.

1. Clothing: If users are dressed in long sleeves or jackets that cover their wrists, the LED lights from their *Barmband* may not be visible. This would make it difficult for one user to recognize another user's matching *Barmband* color.

2. Ambient Lighting: The visibility of the LED lights can also be affected by the lighting conditions in the location the *Barmband* is used. In a pub or bar, where the environment is often dimly lit, the vibrant colors and patterns of the LED strip should stand out. However, in very crowded areas or extremely bright or dark conditions, it may be difficult to distinguish between different colors.

3. Line of sight: Another potential problem could arise if users are sitting or standing in a way that obstructs the line of sight to *Barmband*. This could be particularly problematic in crowded locations where the user may not be immediately visible, making it difficult to identify a matching LED color.

6.5 Authorization

Barmband comes without any authorization. This means that communication between *Barmband* devices is unsecured and therefore vulnerable to unwanted interference. Since we do not verify the identity of the sender, malicious users could potentially send random MQTT messages. This could disrupt the operation of *Barmband* by sending false or misleading information, affecting the user experience. In addition, a malicious user could flood the system with meaningless MQTT messages. This may overload the system, causing a denial-of-service attack.

7 DISCUSSION

7.1 Choosing MQTT over WebSockets

MQTT was selected as the messaging protocol due to its lightweight design, making it suitable for scenarios where network bandwidth may be limited. In contrast, WebSockets are a powerful tool for real-time applications. MQTT was chosen over WebSockets primarily due to its quality of service levels, which ensures messages are always delivered as intended, and the ability to easily debug messages.

7.2 Lack of Usability Studies

It is important to note that no usability studies have been conducted on *Barmband*, except testing *Barmband* on the authors' wrists. Usability studies are essential, as they provide valuable insights into how users interact with the product. Without further studies, assumptions may be made about the user experience and interaction with *Barmband*, which could potentially result in a suboptimal user experience. Conducting a usability study can uncover hidden issues and provide valuable insights into the design and overall functionality of *Barmband*.

7.3 Testing Constraints

Due to budget limitations, testing of *Barmband* has only been conducted with two devices. Although this provides some understanding of the interaction with *Barmband*, the scope is limited, especially considering the use of *Barmband* in social environments with multiple users. To provide a more realistic evaluation of *Barmband*, it is recommended to conduct extensive testing with multiple devices. This will help to identify potential areas of collision or technical issues.

In summary, *Barmband* presents a concept for enhancing social experience. However, further exploration and improvements are necessary.

8 FUTURE WORK

8.1 Smaller form factor

The form factor and appearance of the *Barmband* are critical factors for its usability and acceptance. Future work should aim to develop designs that are both functional and comfortable to wear.

Efforts should be made to miniaturize the essential components of the *Barmband*, such as the RFID reader, LED strip, MCU, and power source, to reduce its size and weight. Additionally, flexible or smaller circuits can be explored to allow the *Barmband* to conform more naturally to the wearer's wrist.

Future iterations could research options for more compact and lightweight power solutions.

In addition, it is important to consider the aesthetic appeal of the *Barmband*. The *Barmband's* appeal can be enhanced by different designs, customizable elements such as changeable bands and multiple color options.

8.2 Health Check

Currently, there is no health check between the *Barmbands* and the management software. This can cause issues in certain circumstances. For instance, if an unexpected problem arises while a *Barmband* is in a challenge, the management software will not be notified as no abort message is sent. Consequently, the *Barmbands* may enter a state where there is no partner to search for. A potential solution could involve implementing regular health checks between the *Barmbands* and management software. If an unexpected issue arises during a challenge, the management software would send an abort message on behalf of the affected *Barmband*, notifying the partner *Barmband* that the challenge has been cancelled.

8.3 Teams

A promising area for future work is the implementation of a team feature. This would involve assigning a group of individuals to the same color, rather than just two people, to create a team-oriented socializing experience.

This feature would promote not only individual interactions but also group dynamics. Participants could use the *Barmband* to identify others within their team color, encouraging them to interact as a group. This could be especially useful for encouraging larger group discussions at events such as networking events, parties, or team-building activities.

However, implementing a team feature would present its set of challenges. Ensuring a seamless and efficient team matching and pairing process can be challenging, particularly in large events with many participants. Identifying team members in crowded spaces may also be a problem. Despite these challenges, developing and innovating in the area of team features could enhance social experiences on *Barmband*.

8.4 Making a Toast

To improve the Barmband experience and create more realistic social interaction triggers, future work could incorporate toast detection as a method of engagement alongside RFID scanning. When two or more *Barmband* wearers clink their wristbands together, the device could register this as the completion of the challenge. This presents a more fun method of engagement compared to scanning RFID tags.

The integration of toast detection would require development in both hardware and software. The use of an accelerometer could allow the *Barmband* to detect the motion and force associated with a toast gesture. In addition, software algorithms will be required to process this data and distinguish between a toast gesture and other movements.

However, this feature also presents some challenges. Accurately detecting the toast gesture without false positives from other activities will be a challenge. Additionally, maintaining a compact design of the *Barmband* with additional hardware requirements will be difficult.

8.5 Improve Graphical User Interface

We provide a simple graphical user interface to view all active *Barmbands*. In future iterations of the GUI, there could be options to manually pair *Barmbands*. The GUI could display all active Barmbands and allow an administrator or event host to initiate pairings between specific devices. This feature could be particularly useful at events where predetermined pairings or groups are required. In addition, the graphical user interface could offer users or event hosts the option to abort challenges between paired *Barmbands*. This would provide greater control over social interactions.

An advanced feature could be the ability to simulate *Barmbands* within the user interface. This adds the ability to test events in advance, anticipating potential problems or bottlenecks. Simulations could consider factors such as the number of users and the size of the location, helping event organizers to optimize the *Barmband* experience for different locations. A simulation could also be done without any further enhancements to the GUI. Instead, a simple MQTT client could be created to parse a file with MQTT messages and send them to the corresponding topics.

9 CONCLUSIONS

Barmband is an innovative approach to enhance social interactions in social environments, mainly in bars and pubs. By integrating technology into a wearable bracelet, *Barmband* aims to provide individuals with a new way to break the ice.

Although there are still several challenges and limitations, such as power supply limitations, LED visibility, and the absence of a secure authentication protocol, *Barmband* shows promise for such social settings.

The project has been tested and evaluated only on two devices due to budget limitations. However, the test was promising and many elements of the *Barmband* have been successfully implemented. Future iterations could explore extensive testing with multiple devices.

In conclusion, the *Barmband* project successfully combines technology with social interaction. *Barmband* creates a bridge between digital and physical space, encouraging friendly interactions. With further development, *Barmband* has the potential to influence the way people connect in the analogue world.

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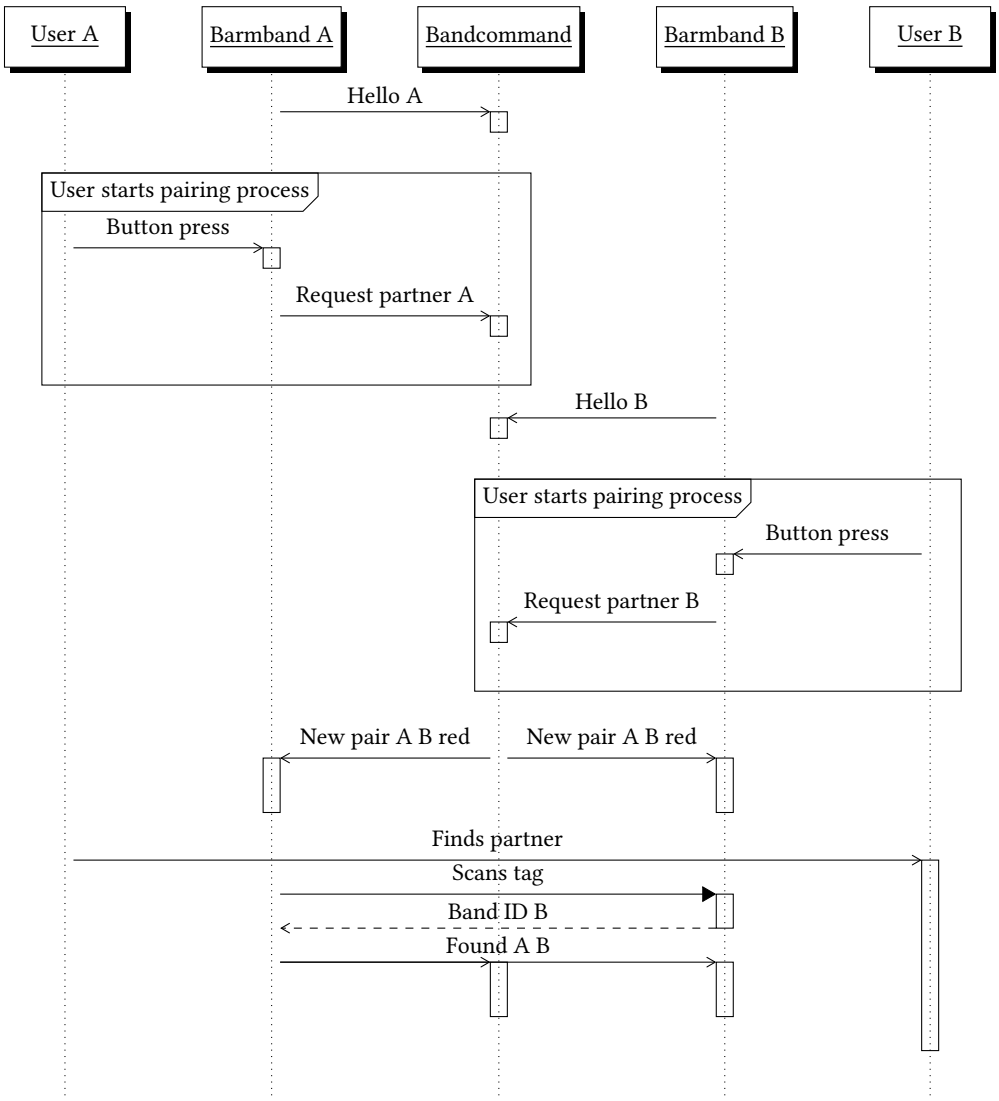

Figure 1: Example communication and user interaction

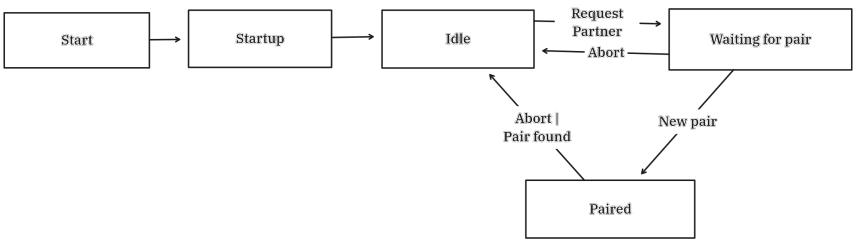

Figure 2: The states a Barmband can be in